Specification

Light control film and backlight unit using the same

[Technical Field]

[0001]

The present invention relates to a light control film ~~used~~ for backlight units such as those used for liquid crystal displays and so forth, and a backlight unit using the same.

[Background Art]

[0002]

For liquid crystal displays ~~and so forth~~, backlight units of the edge light type or direct light type are conventionally used. Since backlight units of the edge light type ~~themselves~~ can be manufactured with a small thickness, they are used for notebook computers etc., whereas backlight units of the direct type are used for large-sized ~~liquid crystal~~ LCD television, etc. ~~in many cases~~.

[0003]

Light ~~s~~ emitted from these conventional backlight units contains components emitted ~~along~~ in directions significantly ~~inclined~~ angled from the front direction~~.~~ ~~Lights~~, especially light emitted from backlight units of the edge light type, ~~in particular, contain a lot of components emitted along directions significantly inclined from the front direction,~~ and thus it is difficult to obtain high front luminance.

[0004]

Therefore, in the conventional backlight units, two or more optical films such as prism sheets and light diffusing films are used in combination in order to improve

front luminance so that the ~~directions of~~ light~~s~~ is ~~should be~~ directed to the front ~~direction~~ (see, for example, Japanese Patent Unexamined Publication (KOKAI) No. 9-127314 (claim 1, paragraph 0034)).

[0005]

Although prism sheets can increase the ~~ratio~~ portion of the light~~s~~ emitted ~~along~~ to the front ~~direction~~ (in a direction perpendicular to film surface) by surface design based on geometric optics. However, they have drawbacks in that they are likely to ~~suffer from~~ exhibit an interference pattern due to regularly arranged convex portions, and in that, ~~they cause glare~~ if ~~they are~~ used alone, they produce glare and thus ~~they~~ impair the visibility of images. Moreover, they unduly concentrate light~~s~~ ~~along~~ to the front ~~direction~~, and therefore they cannot provide a wide viewing angle.

[0006]

On the other hand, if diffusion films are used alone, the front luminance becomes insufficient, although the aforementioned problems are not caused.

[0007]

Therefore, a prism sheet and a light diffusing film are used in combination as described above. However, the front luminance enhanced by the prism sheet is reduced by the ~~use of the~~ light diffusing film. Moreover, the films assembled ~~place~~ in layers may generate Newton rings between the ~~members~~layers, or ~~scratches and so forth generated~~ become scratched due to ~~the~~ their contact ~~of the members may cause a problem~~.

~~[Patent document 1]~~ See Japanese Patent Unexamined Publication (KOKAI) No. 9-127314

~~[Disclosure of the Invention]~~

~~[Problems to be solved by the Invention]~~ SUMMARY OF THE

INVENTION

[0008]

Therefore, an object of the present invention is to provide a light control film that provides improved ~~can surely improve~~ front luminance when ~~it is~~ used alone or in combination with a prism sheet, provides~~d~~ ~~has an~~ appropriate light diffusion~~diffusing property~~, and does not produce an ~~suffer from the problems of~~ interference pattern or ~~and~~ glare, and a backlight unit using the same.

~~[Means for solving the Problems]~~

[0009]

In order to achieve the aforementioned object, the inventor of the present invention ~~conducted various researches~~ studied the ~~on~~ various factors defining the surface profile of light control films such as the convexo-concave profile, lengths, slopes with respect to film surface (base plane), heights and pitches of the convexo-concave portions, and as a result, ~~they~~ found that the front luminance could be improved by appropriately controlling slopes of the rough surface with respect to the ~~film~~ base plane and the profile thereof. ~~and thereby efficiently directing lights entered into the film to the front direction (projection direction).~~

[0010]

More specifically, it was found that superior front luminance could be achieved, if, ~~when a~~ for any cross section 100 in ~~was assumed along~~ an arbitrary direction perpendicular to a film plane (plane of the film ~~a~~ surface ~~on the side~~ opposite ~~to the side of the surface on which~~ the rough surface~~ is formed~~) as shown in Fig. 1, ~~either one of a condition~~ conditions A and B are satisfied. Condition A requires that the average ~~(θ_{ave})~~ of absolute values of slope (degree of angles) of a curve defining the periphery

of the cross section (profile curve 101) ~~was~~ be within a predetermined range (condition A1) and/or that the ~~and a condition that~~ ratio ~~(~~L_r = L2/L1~~) of a length (~~, wherein L1~~)~~ is the length of a straight line 102 defined as an intersection of the film plane and the cross section and ~~a length (L2)~~ is the length of the profile curve 101, be ~~was~~ within a predetermined range (condition A2). ~~was satisfied, and further, a condition~~ Condition B requires that skewness P_{sk} ~~(JIS B0601:2001)~~ of the profile curve, as defined by JISB0601:2001, be ~~is~~ within a predetermined range (condition~~s~~ B1), and/or ~~a condition~~ that kurtosis P_{ku} ~~(JIS B0601:2001)~~ of the profile curve, as defined by JISB0601:2001, be ~~is~~ within a specific range (condition B2). ~~was satisfied, and thus the present invention was accomplished.~~

[0011]

~~Among the aforementioned conditions, the~~ The values ~~used~~ for the conditions A1 and A2 are parameters determining the degree of slopes of ~~convexoconcaves existing~~ the convex and concave forms on the rough surface of the film ~~surface~~, and the values ~~used~~ for the conditions B1 and B2 are parameters determining the shapes of ~~convexoconcaves~~the convex and concave forms. Specifically, the skewness P_{sk} represents asymmetry, i.e., degree of deviation degree, of heights of ~~convexoconcaves~~ convex and concave forms(measure of asymmetry of a probability density function for the height ~~direction~~). For example, ~~as~~ for a ~~one~~ convex shape which~~,~~ ~~if it~~ does not deviate from the central line, P_{sk} is 0, and a larger absolute value of P_{sk} represents larger deviation from the central line, while the sign of P_{sk} differs depending on the ~~toward which~~ direction in which the convex shape deviates. ~~Further,~~ The ~~the~~ kurtosis P_{ku} represents sharpness of the convex and

concave forms ~~convexoconcaves~~ (measure of sharpness of probability density function along the height ~~direction~~), and when the probability density function has a shape of normal distribution, the kurtosis P_{ku} is 3. When the kurtosis P_{ku} is ~~has a value~~ larger than 3~~that value~~, the convex ~~portion~~ form ~~should~~ will have a sharper shape, and when the kurtosis P_{ku} ~~has~~ is ~~a value~~ smaller than 3~~that value~~, the convex ~~portion~~ form ~~should~~ will have a shape with a squashed apex. The light control film of the present invention satisfies, among such conditions ~~concerning~~ for the slope and shape, at least one of A1 and A2, and at least one of B1 and B2.

[0012]

~~That is~~Thus, in one aspect, the light control film of the present invention is a light control film having a rough surface, having~~wherein the rough surface satisfies~~, for ~~an~~ any arbitrary cross section perpendicular to a base plane of the film, ~~a~~ an average ~~condition that average (θ_{ave}, degree)~~ of absolute values of slope, with respect to the base plane of a curve along the edge of the cross section contoured by the rough surface (hereinafter ~~henceforth referred to as~~ "profile curve") of ~~is~~ not less than 20 degrees and not more than 75 degrees, and, for substantially all profile curves, the absolute value for ~~of~~ skewness, according to ~~(~~JIS B0601:2001, ~~) of the profile curve~~ is not more than 1.2 ~~for substantially any profile curve~~ (condition A1 + condition B1).

[0013]

In another aspect, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface of ~~formed by~~ a patterned layer of ~~comprising~~ a material having a refractive index n, wherein the rough surface has ~~satisfies~~, for any arbitrary cross section

perpendicular to a base plane of the film, an ~~condition that~~ average ~~(θ_{ave}, degree)~~ of absolute values for ~~of~~ slope, with respect to the base plane of a curve along the edge of the cross section contoured by the rough surface, ~~(henceforth referred to as "profile curve") is~~ not less than (36 - 10n) degrees and not more than (86 -10n) degrees, and wherein substantially all profile curves have an absolute value of skewness, according to ~~(~~JIS B0601:2001, ~~)~~ of ~~the profile curve is~~ not more than (n - 0.4) ~~for substantially any profile curve~~ (condition A1' (condition A1 considering the refractive index n) + condition B1).

[0014]

In yet another aspect, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface, wherein the rough surface has ~~satisfies~~, for any arbitrary cross section perpendicular to a base plane of the film, an ~~condition that~~ average ~~(θ_{ave}, degree)~~ of absolute values for ~~of~~ slope, with respect to the base plane of a profile curve along the edge of the cross section contoured by the rough surface, ~~(henceforth referred to as "profile curve") is~~ of not less than 20 degrees and not more than 75 degrees, and wherein substantially all profile curves have a kurtosis (JIS B0601:2001) ~~of the profile curve is~~ not less than 1.5 and not more than 5.0 for substantially any profile curve (condition A1 + condition B2).

[0015]

In another aspect, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface formed by a patterned layer of ~~comprising~~ a material having a refractive index n, wherein the rough surface has ~~satisfies~~, for any arbitrary cross section perpendicular to a base plane of the film, an ~~condition~~

~~that~~ average (θ_{ave}, degree) of absolute values for ~~of~~ slope, with respect to the base plane of a profile curve along the edge of the cross section contoured by the rough surface, ~~(henceforth referred to as "profile curve") is~~ not less than (36 - 10n) degrees and not more than (86 -10n) degrees, and wherein substantially all profile curves have a kurtosis (JIS B0601:2001) ~~of the profile curve is~~ not less than 1.5 and not more than (10n - 11) ~~for substantially any profile curve~~ (condition A1' + condition B2).

[0016]

In yet another aspect, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface, wherein the rough surface has ~~satisfies~~, for an arbitrary cross section perpendicular to a base plane of the film, a ~~condition that~~ ratio ~~(~~L_r = L2/L1, ~~) of a length~~ wherein ~~(~~L2~~)~~ is the length of a curve along the edge of the cross section contoured by the rough surface and ~~(henceforth referred to as "profile curve") to a length~~ ~~(~~L1~~)~~ is the length of a straight line defined as an intersection of the base plane and the cross section, of ~~is~~ $1.1 \leqq L_r \leqq 1.8$, and wherein the absolute value of skewness, according to ~~(~~JIS B0601:2001, ~~)~~ of the profile curve is not more than 1.2 for substantially ~~any~~ all cross sections (condition A2 + condition B1).

[0017]

In another aspect, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface on ~~formed by~~ a patterned layer of ~~comprising~~ a material having a refractive index n, wherein the rough surface has ~~satisfies~~, for any arbitrary cross section perpendicular to a base plane of the film, a ~~condition that~~ ratio ~~(~~L_r = L2/L1~~)~~, wherein ~~L_r) a length (~~L2~~)~~ is the length of a profile curve along the edge of the cross section

contoured by the rough surface and ~~(henceforth referred to as "profile curve") to a length (~~L1~~)~~ is the length of a straight line defined as an intersection of the base plane and the cross section, wherein ~~is~~ $(1.9 - 0.5n) \leqq L_r \leqq 1.8$, and wherein substantially all arbitrary cross-sections have an absolute value of skewness, according to ~~(~~JIS B0601:2001,~~)~~ of ~~the profile curve is~~ not more than (n − 0.4) ~~for substantially any cross section~~ (condition A2' (condition A2 considering the refractive index n) + condition B1).

[0018]

In yet another aspect~~Further~~, the light control film of the present invention is ~~also~~ a light control film having a rough surface which has~~, wherein the rough surface satisfies~~, for any arbitrary cross section perpendicular to a base plane of the film, a ~~condition that~~ ratio ~~(~~L_r = L2/L1~~) of a length (~~, wherein L2~~)~~ is the length of the profile ~~a~~ curve along the edge of the cross section contoured by the rough surface and ~~(henceforth referred to as "profile curve") to a length (~~L1~~)~~ is the length of a straight line defined as an intersection of the base plane and the cross section, wherein ~~is~~ $1.1 \leqq L_r \leqq 1.8$, and wherein substantially all arbitrary cross-sections have a kurtosis, according to ~~(~~JIS B0601:2001,~~)~~ of the profile curve which is not less than 1.0 and not more than 4.5 ~~for substantially any cross section~~ (condition A2 + condition B2).

[0019]

In other embodiments, t~~T~~he light control film of the present invention is ~~also~~ a light control film having a rough surface on ~~formed by~~ a patterned layer of ~~comprising~~ a material having a refractive index n, wherein the rough surface has ~~satisfies~~, for an arbitrary cross section

perpendicular to a base plane of the film, a ~~condition that~~ ratio ~~(~~L_r =L2/L1, wherein~~)~~ ~~of a length (L2)~~ is the length of ~~a~~ the profile curve along the edge of the cross section contoured by the rough surface and ~~(henceforth referred to as "profile curve") to a length (L1)~~ is the length of a straight line defined as an intersection of the base plane and the cross section (L_r = L2/L1) is $(1.9 - 0.5n) \leqq L_r \leqq 1.8$, and wherein substantially all profile curves have a kurtosis according to ~~(~~JIS B0601:2001,~~)~~ of ~~the profile curve is~~ not less than 1.0 and not more than (10n - 11.5) ~~for substantially any cross section~~ (condition A2' + condition B2)

[0020]

In the present invention, the "base plane of the film" means a plane of the film regarded as substantially planar, and when the face of the light control film of the present invention opposite to the face on which the convex and concave shapes ~~convexoconcaves~~ are formed is smooth, the plane of this opposing face can be regarded as the base plane. When the opposite face is not smooth but a rough surface, a plane centered between the ~~including the central lines of~~ two different faces ~~directions thereof~~ can be regarded as the base plane.

[0021]

When a profile curve is ~~generally~~ represented as y = f(x), the length ~~(L2)~~ of the profile curve with respect to such a base plane can be represented by the following equation (1) using f'(x) obtained by differentiating f(x) with x.

[0022]

~~[#1]~~

$$L2 = \int_0^{L1} \sqrt{1 + f'(x)^2 dx} \qquad (1)$$

[0023]

Further, slopes of the profile curve relative ~~with respect~~ to the base plane can be generally obtained as f'(x) obtained by differentiating f(x) with x, and average (S_{av}) of absolute values thereof can be represented by the following equation (2) wherein L represents the length of intervals for which the aforementioned values are calculated. Further, when the slopes are indicated as ~~in~~ a unit of angle, the average of absolute values of such slopes (θ_{av}) can be represented by the following equation (3).

[0024]

~~[#2]~~

$$S_{av} = \frac{1}{L} \int_0^L |f'(x)| dx \qquad (2)$$

[0025]

~~[#3]~~

$$\theta_{av} = \frac{1}{L} \int_0^L \left|\tan^{-1} f'(x)\right| dx \qquad (3)$$

[0026]

However, although it is possible to use such a function for product designing, it is almost impossible to describe a profile curve with a general function for an actual product, and thus the length ~~(L2)~~ and the average of absolute values of slopes are difficult to obtain ~~can hardly be obtained, either~~. Therefore, in the present invention, values calculated as follows are defined as the length of the profile curve and the average of absolute

values of slope.

[0027]

First, a profile curve is measured from an arbitrary point on ~~of~~ a rough surface along an arbitrary direction by using a surface profiler. The results of measurement include ~~results are constituted by~~ height data measured at positions (d_1, d_2, d_3 ... d_m) separated by ~~with~~ a predetermined interval ~~(Δd)~~ from each other, ($h(d_1)$, $h(d_2)$, $h(d_3)$ ... $h(d_m)$). This~~These are~~ data ~~that~~ can be represented as a curve in a graph in which the vertical axis indicates height of the convex and concave shapes ~~convexoconcaves~~ and the horizontal axis indicates the direction of the profile curve, for example, as shown in Fig. 2. Portions of the profile curve, each corresponding to one interval (e.g., (a-b), (c-d)), can be regarded as straight lines, if the interval is sufficiently short, and the lengths thereof λ_i (i = 1, 2, 3 ... m-1) can be represented by the following equation (4).

[0028]

~~[#4]~~

$$\lambda_i = \sqrt{(h(d_i) - h(d_{i+1}))^2 + \Delta d^2} \qquad (4)$$

[0029]

Then, the lengths obtained for all the portions of the profile curve corresponding to a predetermined interval (Δd) are summed to obtain L2, as represented by the following equation (5).

[0030]

~~[#5]~~

$$L2 = \sum_{i=1}^{m-1} \lambda_i \qquad (5)$$

Further, absolute value θ_i ($i = 1, 2, 3 \ldots m-1$) of slope of a portion of the profile curve corresponding to one interval as described ~~mentioned~~ above can be represented by the following equation (6) wherein the unit is degrees ~~(unit is "degree")~~.

[0031]

~~[#6]~~

$$\theta_i = \tan^{-1}\left(\frac{h(d_{i+1}) - h(d_i)}{\Delta d}\right) \qquad (6)$$

[0032]

Further, average of the aforementioned slopes obtained for all the portions of the profile curve divided into the predetermined interval (Δd) as shown in the following equation (7) is used as the average of absolute values of slope θ_{ave}.

[0032]

~~[#7]~~

$$\theta_{ave} = \frac{1}{m}\sum_{i=1}^{m}|\theta_i| \qquad (7)$$

[0034]

The length of the aforementioned interval (Δd) is chosen such ~~a length~~ that the profile of the rough surface is ~~included in the profile curve can be~~ sufficiently correctly represented by the profile curve, i.e. ~~reflected, and it is specifically~~ an interval of about 1.0 μm or

shorter.

[0035]

The backlight unit of the present invention is a backlight unit comprising a light guide plate and a ~~provided with~~ a light source directed ~~for~~ at least at one edge surface ~~end portion~~ thereof, the light guide plate ~~and~~ having a light emergent surface approximately perpendicular to the edge surface ~~end portion~~ and a light control film of the present invention provided on the light emergent surface of the light guide plate~~, wherein the aforementioned light control film is used as the light control film~~.

The backlight unit of the present invention may further include ~~be the aforementioned backlight unit, wherein~~ a prism sheet ~~is used~~ between the light control film and the light guide plate.

[0036]

The backlight unit of the present invention may ~~is~~ also be a backlight unit comprising a light source, a light diffusive plate provided on one side of the light source and the ~~a~~ light control film of the present invention provided on the side of the light diffusive plate opposite to the light source ~~side, wherein the aforementioned light control film is used as the light control film~~.

~~[Effect of the Invention]~~

[0037]

The light control film of the present invention can increase the amount ~~components~~ of light emitted in~~s of~~ the front direction, in particular, those ~~in the range of~~ emissions at an angle of 0 to 30 degrees, for light~~s~~ entering~~ed~~ from the surface opposite ~~to~~ the rough surface and emitted from the rough surface, and thus provide ~~it can attain~~ markedly higher front luminance as compared with the

usual diffusing films. In addition, it also ~~has~~ provides appropriate light diffusion ~~diffusing property~~ and does not generate glare or ~~and~~ interference pattern.

[0038]

Accordingly~~Further~~, the backlight unit of the present invention is a backlight unit which provides ~~providing~~ high front luminance and~~, having~~ appropriate light diffusion ~~diffusing property~~, and which does not generate~~ing~~ glare or an~~d~~ interference pattern, due to ~~because it~~ use of a ~~s the~~ particular light control film. Moreover, it can prevent scratching of ~~generation of scratches on~~ a prism sheet due to contact with other members~~ and so forth~~.

Brief Description of the Drawings

[0151]

Fig. 1 shows a light control film with a rough surface in accordance with the present invention.

Fig. 2 shows a profile curve of the light control film the present invention.

Figs. 3(a)-3(b) are sectional views of embodiments of the light control films of the present invention.

Fig. 4-1 is a sectional view of a three-dimensional shape of a convex portion used to stimulate differences in emergent angle characteristics due to differences in shape.

Fig. 4-2 is a perspective view of the three-dimensional shape of the convex portion shown in Fig. 4-1.

Fig. 5 is a graph of the results of three-dimensional simulation.

Fig. 6 is another graph of results of three-dimensional simulation.

Fig. 7 is another graph of results of three-dimensional simulation.

Fig. 8 is yet another graph of results of three-dimensional simulation.

Fig. 9 is another graph of results of three-dimensional simulation.

Fig. 10 is another graph of results of three-dimensional simulation.

Fig. 11 is another graph of results of three-dimensional simulation.

Fig. 12 is a perspective view of an example of the rough surface of the light control film of the present invention.

Fig. 13 is a schematic of an embodiment of a backlight unit of the present invention.

Fig. 14 is a schematic of another embodiment of a backlight unit of the present invention.

~~[Best Mode of Carrying Out the Invention]~~DESCRIPTION OF PREFERRED EMBODIMENTS

[0039]

~~Hereafter,~~ T~~t~~he light control film and backlight unit of the present invention will now be explained in detail with reference to the drawings. The sizes (thickness, width, height etc.) of the elements illustrated in the drawings ~~used~~ for explanation of the present invention are enlarged or reduced as required for explanation and do not reflect the ~~actual~~ sizes of the elements of an actual light control film ~~and~~ or actual backlight unit.

[0040]

Figs. 3 (a) to 3 (c) schematically show examples of the light control film of the present invention. As shown in the drawings, the light control film of the present invention has fine convex and concave shapes ~~convexoconcaves~~ formed on one face of a substantially planar film and defining ~~has~~ a characteristic profile in cross-section ~~of the convexoconcaves~~. The convex and

concave shapes ~~convexoconcaves~~ may be formed on a layer provided on one face of a film used as a substrate as shown in 3 (a) and 3 (b), or on a surface of the light control film itself, i.e. ~~may be constituted with~~ a single layer on which convex and concave shapes ~~convexoconcaves~~ are formed as shown in 3 (c).

[0041]

When lights~~s~~ enters into the light control film of the present invention from the surface opposite ~~to~~ the rough surface on ~~which~~ which the convex and concave shapes ~~convexoconcaves~~ are formed and ~~are~~ is emitted from the rough surface, the light control film of the present invention controls direction of the light~~s~~ so that the ~~components~~ amount of the light~~s~~ emitted ~~with~~ at an angle ~~with respect~~ to the front direction within a predetermined range ~~should~~ is increased to enhance front luminance, and light ~~diffusing property which can~~diffusion prevents glare~~s~~ ~~should be provided~~. Although the surface opposite ~~to~~ the surface on which convex and concave shapes ~~convexoconcaves~~ are formed is typically a smooth surface, it is not limited to a smooth surface. For example, ~~matting~~ the opposing surface may be ~~performed~~ matted or provided with a predetermined dot pattern~~etc. may be formed on the surface~~.

[0042]

Hereafter, the ~~conditions concerning~~factors providing the profile of the convex and concave shapes ~~convexoconcaves~~ for controlling direction of light~~s~~ as described above will be explained.

[0043]

In the present invention, conditions (criteria) for obtaining optimum ~~emergent~~ light~~s~~ emission were first investigated for a single convex portion (Fig. 4-2) ~~consisting of a~~ (revolution body) formed by rotating such

an arbitrary curve such as shown in Fig. 4-1 on a xy-plane, serving as a base plane, around a z-axis perpendicular to the xy-plane ~~by~~, simulating the relationship between incident light~~s~~ and emergent light~~s~~ in a three-dimensional space while changing the convex shape, height thereof, angle of incident light and so forth. ~~And~~ D~~d~~istribution of light~~s~~ emerging from the convex side (emergent angle characteristics) was obtained by calculation for the case where light~~s~~ having the same distribution as that of light~~s~~ emerging from a light guide plate in an actual backlight unit enters from the bottom face opposite the side of the ~~convex~~ convex shape~~portion~~. The calculation was performed by assuming that the refractive index of the inside of the convex shape ~~portion~~ was 1.5, which is the refractive index of a common acrylic resin.

[0044]

Fig. 5 shows a graph representing distribution of emergent lights~~, which is a result of~~ produced by simulation performed for the convex portion having the shape shown in Fig. 4-2. In the graph, the solid line represents distribution of emergent light~~s~~, and the dotted line represents distribution of incident light~~s~~. In order to provide favorable front luminance and light scattering ~~property of~~to a certain degree, it is desirable that most components of the light~~s~~ ~~emergning with~~emerge at an angle within the range of ~~the front direction (~~0 degree~~)~~ ± 30 degrees ~~should be abundant~~to the front direction.

[0045]

Then, in order to find conditions for obtaining emergent light characteristics satisfying ~~such conditions~~the above-mentioned criteria for a rough surface on which multiple convex portions are formed, change of emergent light distribution was simulated while the shape

of the convex ~~portions~~ forms and height thereof were ~~variously~~ changed for a ~~system~~ light control film having a multiple number of the convex ~~portions mentioned above~~forms.

The results of the simulation of the relationship between the average of absolute values of slope of the profile curve (θ_{ave}) and energy of the emergent light~~s~~ are shown in the graph of Fig. 6. In the graph, the horizontal axis represents average of absolute values of slope of a profile curve (θ_{ave}), and the vertical axis represents energy of emergent light~~s~~. The points of the first group 601 indicate ~~energies~~ energy of emergent light~~s~~ within the range of not more than 6 degrees about the z axis (henceforth referred to as "emergent light~~s~~$_{6}$"), those of the second group 602 indicate ~~energies~~ energy of emergent light~~s~~ within the range of not more than 18 degrees about the z axis (henceforth referred to as "emergent light~~s~~$_{18}$"), and those of the third group 603 indicate ~~energies~~ energy of emergent light~~s~~ within the range of not more than 30 degrees about the z axis (henceforth referred to as "emergent light~~s~~$_{30}$").

[0046]

In the simulation results, there was observed a tendency ~~that~~ of the ratio of the emergent light$_{30}$ to increase~~d~~ as the average of absolute values of slopes ~~(θ_{ave})~~ became larger, but when θ_{ave} exceeded ~~it became further larger exceeding~~ a certain level, the ratio conversely decreased. Therefore, a comprehensive index of convexo-concave profiles providing correlation with the emergent light$_{30}$ was investigated. As a result, it was found that if the skewness P_{sk} defined in JIS B0601:2001 or the kurtosis P_{ku} defined in JIS B0601:2001 was used for a profile curve appearing on a rough surface of a light control film, the relation with the emergent light$_{30}$ could be best

~~described~~defined.

[0047]

Figs. 7 and 8 show graphs representing the results of the simulation, and both represent change of the emergent light energy with change of the average of absolute values of slopes ~~(~~θ_{ave}~~)~~ plotted ~~in~~ on the horizontal axis.

[0048]

From these simulation results, it was found that the energy of emergent light~~s~~ having an emergent angle of 30 degrees or less tended to sharply increase when the average of absolute values of slope of the profile curve (θ_{ave}) was not less than 20 degrees and not more than 70 degrees, whereas there were some cases where ~~the rate~~ that portion of the emergent $light_{30}$ did not become high even if the average of absolute values of slope of the profile curve ~~(~~θ_{ave}~~)~~ was within the aforementioned range. However, it was found that if only the results obtained with an absolute value of the skewness ~~(~~P_{sk}~~)~~ of the profile curve not more than 1.2 (points ~~of~~ "●" 604 in Fig. 7) were observed, the ~~rate~~ portion of the emergent $light_{30}$ was always high. Moreover, it was found that if only the results obtained with a kurtosis (P_{ku}) of the profile curve not less than 1.5 and not more than 5.0 (points ~~of~~ "●" 605 in Fig. 8) were observed, the ~~rate~~ portion of the emergent $light_{30}$ was always high.

[0049]

When the average of absolute values of slopes of the profile curve (θ_{ave}) is not less than 20 degrees and not more than 70 degrees, preferably not less than 20 degrees and not more than 60 degrees, more preferably not less than 20 degrees and not more than 50 degrees, if the absolute value of the skewness (P_{sk}) of the profile curve is not more than 1.2, preferably not more than 1.1, or the

kurtosis (P_{ku}) of the profile curve is not less than 1.5 and not more than 5.0, preferably not less than 1.5 and not more than 4.5, a particularly superior effect can be obtained.

[0050]

The results of the simulation of the relationship between the ratio (L_r) of the lengths of the profile curve and the energy of emergent light~~s~~ are shown in Fig. 9. In the graph, the horizontal axis indicates the ratio ~~(L_r)~~ of the length of the profile curve to ~~a~~ the length of a straight line defined as an intersection of the base plane and the cross section, and the vertical axis indicates energy of the emergent light~~s~~. The points of the first group 901 indicate energies of emergent light~~s~~ within the range of not more than 6 degrees about the z axis (~~henceforth referred to as~~hereinafter "emergent light~~s~~$_6$"), those of the second group 902 indicate energies of emergent light~~s~~ within the range of not more than 18 degrees about the z axis (~~henceforth referred to as~~hereinafter "emergent light~~s~~$_{18}$"), and those of the third group 903 indicate energies of emergent light~~s~~ within the range of not more than 30 degrees about the z axis (~~henceforth referred to as~~hereinafter "emergent light~~s~~$_{30}$").

[0051]

In the simulation results, there was observed a tendency ~~that~~ of the ratio of the emergent light$_{30}$ to increase~~d~~ as the ratio (L_r) of the lengths became larger, but when ~~it became further larger exceeding~~L_r exceeded a certain level, the ratio conversely decreased. Therefore, a comprehensive index of convexo-concave profiles providing correlation with the emergent light$_{30}$ was investigated. As a result, it was found that if the skewness P_{sk}, as defined in JIS B0601:2001, or the kurtosis, P_{ku} as defined in JIS

B0601:2001, was ~~used for a~~the profile curve ~~appearing on~~for a rough surface of a light control film, the relation with the emergent light$_{30}$ ~~can be~~is best ~~described~~defined.

[0052]

Figs. 10 and 11 show graphs representing the results of the simulation, and both represent change of the emergent light energy with change of the ratio of the lengths ~~(~~L_r~~)~~ plotted ~~in~~ on the horizontal axis.

From these simulation results, it was found that the energy of emergent light~~s~~ having an emergent angle of 30 degrees or less tended to sharply increase when the ratio of the lengths ~~(~~L_r~~)~~ was not less than 1.1 and not more than 1.8, whereas there were some cases where the ~~rate~~portion of the emergent light$_{30}$ did not become high even if the ratio of the lengths ~~(~~L_r~~)~~ was within the aforementioned range. However, it was found that for ~~if only the results obtained with~~ an absolute value of the skewness (P_{sk}) of the profile curve not more than 1.2 (points of "●" 904 in Fig. 10) ~~were observed~~, the ~~rate~~portion of the emergent light$_{30}$ was always high. Moreover, it was found that for ~~if only the results obtained with~~ a kurtosis (P_{ku}) of the profile curve not less than 1.0 and not more than 4.5 (points of "●" 905 in Fig. 11) ~~were observed~~, the ~~rate~~portion of the emergent light$_{30}$ was always high.

[0053]

When the ratio of the lengths ~~(~~L_r~~)~~ is not less than 1.1 and not more than 1.8, preferably not less than 1.2 and not more than 1.7, more preferably not less than 1.3 and not more than 1.6, if the absolute value of the skewness ~~(~~P_{sk}~~)~~ of the profile curve is not more than 1.2, preferably not more than 1.1, or the kurtosis (P_{ku}) of the profile curve is not less than 1.0 and not more than 4.5, preferably not less than 1.0 and not more than 4.0, a

particularly superior effect can be obtained.

[0054]

The ~~conditions~~ criteria described above must be satisfied for substantially ~~any~~ all cross-sections. The expression "substantially ~~any~~ all cross-sections" ~~is used to~~ means that it is sufficient that the ~~conditions should be~~foregoing criteria are satisfied for almost all of multiple observed cross-sections ~~when observation is performed for multiple cross sections for~~of a certain specific light control film, ~~and it include~~inclusive of a case ~~that~~ where the ~~conditions~~ criteria are not satisfied for one or two ~~cross~~ cross-sections. For example, for a ~~cross~~ cross-section in an end portion of the light control film ~~is considered as the cross section~~, the aforementioned ~~conditions~~ criteria may not be satisfied~~,~~ because of an insufficient number of convex and concave shapes ~~convexoconcaves do not exist in a sufficient number~~. However, ~~if the aforementioned conditions are satisfied~~ for a comparatively long profile curve, ~~it is considered that~~ the aforementioned ~~conditions are~~criteria should be satisfied.

[0055]

In the aforementioned simulation for ~~finding~~ identifying the ~~conditions~~ criteria which the rough surface of the present invention must satisfy, the convex ~~portions~~ shapes were assumed to ~~consist~~ be formed of a material having a refractive index of 1.5. However, materials generally used for optical films can be used for the patterned layer of the light control film of the present invention, and the refractive index thereof is not limited to 1.5. If the ~~condition~~ criterion is ~~generalized~~ expressed in ~~consideration~~ terms of the refractive index n, when the average of absolute values of slope of the profile

curve ~~(~~θ_{ave}~~)~~ is not less than (36 - 10n) degrees and not more than (86 - 10n) degrees, and the absolute value of skewness of the profile curve is not more than (n - 0.4) or the kurtosis of the profile curve is not less than 1.5 and not more than (10n -11.5), the aforementioned desired effect can be obtained. Further, when the ratio of the lengths ~~(~~L_r~~)~~ is not less than (1.9 - 0.5n) and not more than 1.8, and the absolute value of skewness of the profile curve is not more than (n - 0.4) or the kurtosis of the profile curve is not less than 1.0 and not more than (10n - 11.5), the ~~aforementioned~~ desired effect can also be obtained.

[0056]

By designing the convexo-concave profile ~~in~~ taking into consideration ~~of~~ the refractive index of the material ~~constituting~~ of the patterned layer as described above, the luminance ~~for~~ in the front direction can be further improved.

[0057]

By designing the rough surface so that it ~~should satisfy~~ satisfies the aforementioned ~~conditions~~criteria, the light control film of the present invention ~~can~~ will exhibit high front luminance, and ~~have a~~provide a certain degree of light ~~diffusing property of a certain~~diffusion~~degree~~. The light control film of the present invention ~~having such characteristics~~meeting the foregoing criteria is disposed, for example, directly on a light guide plate of a backlight unit of the edge light type, or via a light ~~diffusive~~ diffusion member on a light source of a backlight unit of the direct type, and used as a film for controlling the direction of emergent light~~s~~ of the backlight unit.

[0058]

So long as the profile curves of the rough surface of

the light control film of the present invention ~~satisfy~~ satisfy the aforementioned ~~conditions~~criteria, the shape and arrangement of the convex ~~portions~~ projections are not particularly limited. However, the convex ~~portions~~ projections and concave ~~portions~~ recesses are preferably randomly arranged. If a random arrangement is used, it becomes easy to satisfy the aforementioned ~~conditions~~ criteria for substantially any section (substantially all sections), and generation of an interference pattern ~~can be~~is easily prevented. Individual convex portions and concave portions may have the same shape or different shapes, and they may ~~be arrange so that they should~~ overlap with one another, ~~or a~~i.e. part of all of the convex portions and concave portions ~~should~~ may overlap with one another. The height of the convex portions and depth of the concave portions are both about 3 to 100 μm, and ~~arrangement~~ the density of the convex portions or the concave portions is preferably about 10 to 200,000 portions/mm^2. A typical rough surface of the light control film satisfying the aforementioned ~~conditions~~ criteria is shown in Fig. 12.

[0059]

Hereinafter, specific configurations for ~~producing~~ the light control film having the ~~aforementioned~~ above-described rough surface will be explained.

[0060]

~~As the material constituting t~~The substrate 11 and the patterned layer 12 of the light control film 10 of the present invention, may be formed of any material~~s~~ generally used for optical films~~ can be used~~. Specifically, the material for the substrate 11 is not especially limited so long as ~~a material exhibiting~~it exhibits favorable light transmission~~ property is chosen~~, and plastic films such as

~~those~~ films of polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polycarbonate, polyethylene, polypropylene, polystyrene, triacetyl cellulose, polyacrylate, polyvinyl chloride, and so forth can be used.

[0061]

The material for ~~constituting~~ the patterned layer 12 is not also especially limited so long as ~~a material exhibiting~~it exhibits favorable light transmission property ~~is chosen, and glass~~. Thus, polymer resins, and so forth can be used. Examples of ~~the~~ suitable glass include oxide glass such as silicate glass, phosphate glass, and borate glass. Examples of ~~the~~ suitable polymer resins include thermoplastic resins, thermosetting resins, and ionizing radiation curable resins such as polyester resins, acrylic resins, acrylic urethane resins, polyester acrylate resins, polyurethane acrylate resins, epoxy acrylate resins, urethane resins, epoxy resins, polycarbonate resins, cellulose resins, acetal resins, vinyl resins, polyethylene resins, polystyrene resins, polypropylene resins, polyamide resins, polyimide resins, melamine resins, phenol resins, silicone resins, and fluorocarbon resins~~, and so forth~~.

[0062]

Among these~~ materials,~~ polymer resins, ~~are~~ those preferred in view of workability and handling property, and those having a refractive index (JIS K7142:1996) of about 1.3 to 1.7 are especially preferably used. Even if a material having a refractive index n out of the aforementioned range is used ~~as a material constituting~~for the patterned layer, favorable luminance can be realized so long as the aforementioned conditions (A1 OR A2) AND (B1 OR B2) are satisfied. However, by using a material having a refractive index within such a range, high luminance can be

obtained. In particular, by designing the rough surface ~~so that it should~~to satisfy the conditions (A1′ OR A2′) AND (B1 OR B2), defined depending on the refractive index of the material, front luminance can be further improved.

[0063]

Although the patterned layer 12 may comprise light diffusing agents such as beads of organic materials and inorganic pigments, like ~~general~~ conventional light diffusive sheets, ~~they~~ such diffusing agents are not indispensable~~. The~~ because the light control film of the present invention ~~can exert~~produces a light diffusing effect to a certain degree by the rough surface itself, even if it does not ~~comprise~~ contain light diffusing agents. If light diffusing agents are not used, ~~other members are~~adjacent elements will not be damaged by the light diffusing agents, and ~~or~~ dust will not be generated from the light diffusing agents ~~do not separate and fall to generate dusts~~.

[0064]

~~As the method for forming t~~The patterned layer 12, is preferably formed by 1) ~~a method of~~ using an embossing roller, 2) ~~a method of using~~ an etching treatment, ~~and~~ or 3) ~~a method of using~~ molding ~~with a mold can be employed~~. However, ~~a production method of using a mold~~molding is preferred~~,~~ because it enables production of light control films having a predetermined patterned layer with good reproducibility. Specifically, the ~~production~~ patterned layer 12 can be ~~attained~~ obtained by preparing a mold having a profile complementary to that of the rough surface, casting a material ~~constituting the patterned layer~~ such as a polymer resin~~s~~ into the mold, curing the material, and taking out the cured material from the mold. When a substrate is used, the ~~production~~ patterned layer 12 can be

~~attained~~ obtained by casting a polymer resin or the like into the mold, superimposing a transparent substrate thereon, curing the polymer resin ~~or the like~~, and taking out the cured material together with the transparent substrate from the mold.

[0065]

Although the method of forming a profile complementary to the rough surface in the mold is not particularly limited, the following method can be employed. For example, convex portions having a specific shape are formed on a plate so that the ~~arrangement~~ density of the portions is ~~should be~~ several thousands ~~portions~~convex shapes/mm^2~~,~~ ~~by~~ using a laser microprocessing technique, and this plate is used as a male mold to prepare a female mold ~~for molding (female mold)~~. The ~~convex portions having a~~ specific shape ~~means~~ of the convex portions is such ~~convex portions~~ that when profile curves are measured for one whole convex portion ~~with~~ at equal intervals of a length that ~~allows correct reflection of~~correctly reflects the shape of the convex portion (1.0 μm or shorter), the average thereof ~~should~~ satisf~~y~~iesy the conditions (A1 or A2) and (B1 or B2). Alternatively, resin plates having a convex-concave layer are prepared by curing a resin containing particles of a predetermined particle size dispersed therein, the surfaces of the patterned layers are measured by using a surface profiler to choose a resin plate satisfying the aforementioned conditions, and a ~~mold for molding (~~female mold~~)~~ is prepared by using the chosen plate as a male mold.

[0066]

Although the surface of the light control film opposite ~~to~~ the ~~surface consisting of the~~ rough surface may be smooth, alternatively it may be subjected to a fine

matting treatment in order to prevent generation of Newton rings when the film is brought into contact with a light guide plate or resin plate, or an antireflection treatment in order to improve light transmittance.

[0067]

Moreover, in order to obtain favorable front luminance, as an optical characteristic of the light control film, the film desirably has a haze of 60% or more, preferably 70% or more. The haze referred to herein is a value ~~of the~~for haze as defined in JIS K7136:2000, and is ~~a value~~ obtained in accordance with the equation: Haze (%) = $[(\tau_4/\tau_2) - \tau_3(\tau_2/\tau_1)] \times 100$ (τ_1: flux of incident light, τ_2: total light flux transmitted through a test piece, τ_3: light flux diffused in a unit, τ_4: light flux diffused in the unit and test piece).

[0068]

Although the total thickness of the light control film is not particularly limited, it is usually about 20 to 300 μm.

[0069]

The light control film of the present invention ~~explained~~ described above ~~is mainly~~may be used ~~as a member of~~in a backlight unit constituting a liquid crystal display, light signboard, ~~and so forth~~or the like.

[0070]

~~Hereafter, the backlight unit of the present invention will be explained.~~ The backlight unit of the present invention consists of at least a light control film and a light source~~. As~~ wherein the light control film~~,~~ is the aforementioned light control film ~~is used~~. Although the ~~direction~~ arrangement of the light control film ~~arranged in~~within the backlight unit is not particularly limited, ~~it is preferably used so that~~ the rough surface

~~should~~ preferably serves as ~~a~~ the light emergent surface~~-side~~. ~~For t~~The backlight unit~~, a configuration called~~ may be the edge light type or the direct type ~~is preferably employed~~.

[0071]

A backlight unit of the edge light type consists of a light guide plate, a light source ~~disposed on~~directed toward at least one ~~end~~ edge surface of the light guide plate, and a light control film disposed on the light emergent surface side of the light guide plate~~, and so forth~~. The light control film is preferably used ~~so that the~~, with its rough surface ~~should serve~~serving as the light emergent surface. Further, a prism sheet is preferably used between the light guide plate and the light control film. With such a configuration, a backlight unit exhibiting a superior balance of front luminance and ~~a~~ view angle, and ~~not exhibiting~~without glare~~,~~ which is a problem peculiar to a prism sheet, can be provided.

[0072]

The light guide plate has a substantially plate-like shape with at least one ~~of which sides serves~~edge surface serving as a light ~~entering~~ receiving surface and one ~~of which surfaces~~surface perpendicular to the side ~~serves~~ surface serving as a light emergent surface, and mainly consists of a matrix resin selected from highly transparent resins such as polymethyl methacrylate. Resin particles having a refractive index different from that of the matrix resin may be added as required. Each surface of the light guide plate ~~may~~ need not be a uniform plane, but ~~has~~ may have a complicated surface profile, or may be ~~subjected to diffusion printing such as~~printed with a dot pattern or the like to provide diffusion.

[0073]

The light source is disposed ~~for~~ directed toward at least one ~~end~~ edge surface of the light guide plate, and is usually a cold-cathode tube ~~is mainly used~~. Examples of the shape of the light source include a linear shape, L-shape, and so forth.

[0074]

Besides the aforementioned light control film, light guide plate, and light source, the backlight unit of the edge light type is provided with a light reflector, a polarization film, an electromagnetic wave shield film etc., depending on ~~the purpose~~its intended use.

[0075]

One embodiment of the backlight unit of the edge light type according to the present invention is shown in Fig. 13. This backlight unit 140 has ~~a configuration that~~ light sources 142 ~~are provided~~ on both sides of a light guide plate 141, and a light control film 143 is placed ~~upside~~ on the light guide plate 141 ~~so that a~~to provide an outward facing rough surface ~~should be outside~~. The light sources 142 are covered with ~~light source~~ rear reflectors 144 except for ~~the parts~~an area facing the light guide plate 141 so that light~~s~~ from the light source ~~should~~ efficiently enters into the light guide plate 141. Moreover, a light reflector 146 ~~stored in~~within a chassis 145 is provided under the light guide plate 141. ~~By~~ With this configuration, light~~s~~ emitted from the side of the light guide plate 141 opposite ~~to~~ the emergent side ~~are~~ is returned into the light guide plate 141 ~~again~~ to increase the amount of light~~s~~ emerging from the emergent surface of the light guide plate 141.

[0076]

A backlight unit of the direct type consists of a light control film, ~~and~~ a light diffusive member and a

light source disposed, in this order, on a surface of the light control film opposite ~~to~~ the light emergent surface~~, and so forth~~. The light control film ~~is~~ preferably ~~used so that~~has the rough surface ~~should serve~~serving as the light emergent surface. Moreover, a prism sheet is preferably ~~used~~ included between the light diffusive member and the light control film. With such a configuration, a backlight unit exhibiting superior balance of front luminance and ~~a~~ view angle ~~and not exhibiting~~ , without glare~~,~~ which is a problem peculiar to a prism sheet, can be provided.

[0077]

The purpose of the light diffusive member is ~~for erasing a pattern~~to eliminate any image of the light source~~, and a~~. A milky resin plate, a transparent substrate on which a dot pattern is formed on a portion corresponding to the light source (lighting curtain) ~~as well as~~or a so-called light diffusing film having a convexo-concave light diffusing layer on a transparent substrate, ~~and so forth~~ can be used individually or in a suitable combination, as the light diffusive member.

[0078]

~~As the~~The light source~~,~~ is usually a cold-cathode tube ~~is mainly used. Examples of the~~. The ~~shape of~~ the light source ~~include~~ may have a linear shape or a, L-shape~~, and so forth~~. ~~Besides~~ In addition to the aforementioned light control film, light diffusive member, and light source, the backlight unit of the direct type may ~~be provided with~~also include a light reflector, a polarization film, an electromagnetic wave shield film, etc., depending on the ~~purpose~~intended use.

[0079]

One embodiment of the backlight unit of the direct type according to the present invention is shown in Fig. 14.

This backlight unit 150 has ~~a configuration that~~ plural light sources 152 ~~are~~ provided above a light reflector 156 ~~stored in~~within a chassis 155, and a light control film 153 is placed thereon via a light diffusive member 157 as shown in the drawing.

[0080]

Because the backlight unit of the present invention utilizes a light control film having a specific rough surface ~~as a light control film that controls~~to control direction of light~~s~~ emitted from ~~a~~ the light source or ~~a~~ the light guide plate, ~~it can improve~~ front luminance is improved as compared with conventional backlights~~, and~~ which suffer~~s~~ from the problems of glare and ~~generation of scratches in less degrees compared with the case of using a prism sheet alone~~scratches.

[Examples]

[0081]

Hereinafter, the present invention will be further explained with reference to examples.

[Examples 1 to 4]

Four ~~kinds of~~ molds (1) to (4) on which predetermined convexo-concave profiles were formed by a laser microprocessing technique were prepared, an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds (1) to (3), and a silicone resin having a refractive index of 1.40 was poured into the mold (4). Subsequently, the ~~poured~~ resins poured into the molds were cured, and then ~~taken out~~removed from the molds to obtain light control films (1) to (4) having a size of 23 cm (for the ~~direction~~ dimension perpendicular to the light source) x 31 cm (for the ~~direction~~ dimension parallel to the light source) (light control films of Examples 1 to 4).

[0082]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (1) to (4) were measured according to JIS B0601:2001 by using a surface profiler (SAS-2010 SAU-II, MEISHIN KOKI). This surface profiler had a contact finger in the shape of a cone with a spherical tip ~~of which~~having a radius ~~was~~ of 2 µm and a conical angle of 60 degrees. The measurement interval was 1.0 µm. The measurement was performed at 5 arbitrary ~~5~~ positions on each light control film ~~for~~ , in arbitrary directions, and averages of absolute values of slopes to the light entering surface (θ_{ave}) of the obtained profile curves were calculated. Further, for the same profile curves, values of the skewness (P_{sk}), as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (1) to (4) are shown in Table 1 (the unit of slope ~~is "degree"~~being in degrees). Further, by using a turbidimeter (NDH2000, Nippon Denshoku), hazes of the light control films (1) to (4) were measured according to JIS K7136:2000. The ~~measurement~~ results of these measurements are ~~also~~ shown in Table 1.

[0083]

[Table 1]

	θ_{ave} (degree)	| P_{sk} |	haze (%)
Example1	43.6	0.916	97.3
	44.1	0.937	
	42.4	0.940	
	44.7	0.958	
	45.4	0.926	
Example2	38.6	0.595	75.5
	37.5	0.599	
	37.9	0.596	
	38.5	0.613	
	40.4	0.609	
Example3	25.5	0.055	78.9
	25.6	0.057	
	26.4	0.057	
	24.5	0.057	
	26.6	0.053	
Example4	38.6	0.645	74.6
	37.7	0.663	
	39.8	0.655	
	37.0	0.622	
	36.8	0.630	

[0084]

As seen from the results shown in Table 1, the light control films of Examples 1 to 4 showed averages of absolute values of slopes not less than 20 degrees and not more than 75 degrees for all the profile curves. Further,

the absolute values of ~~the~~ skewness were not more than 1.2 for all the profile curves. Moreover, all the light control films of Examples 1 to 4 had a haze of 70% or higher, and thus satisfied the optical characteristics required for obtaining favorable front luminance.

[0085]

Then, the light control films (1) to (4) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (1) to (4) were each disposed on a light guide plate so that the rough surface ~~should~~ served as the light emergent surface, and the luminance was measured at each emergent angle for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (1) to (4) are shown in Table 2 (units ~~is~~ of "cd/m^2").

[0086]

[Table 2]

		luminance (cd/m²)			
		Example 1	Example 2	Example 3	Example 4
parallel direction	left 45 deg.	1010	1030	1100	1050
	left 30 deg.	2160	2100	1860	2020
	0 deg.	2460	2380	2030	2260
	right 30 deg.	2120	2070	1840	1990
	right 45 deg.	999	1020	1090	1040
perpendicular direction	up 45 deg.	713	772	1030	860
	up 30 deg.	2290	2240	2010	2160
	0 deg.	2460	2380	2030	2260
	down 30 deg.	2270	2220	2010	2150
	down 45 deg.	703	762	1020	850

[0087]

~~It was demonstrated by t~~The results shown in Table 2 demonstrate that, for the light control films of Examples 1 to 4, ~~only~~ by incorporating only one sheet of light control film into the backlight unit, the luminance for emergent angles of 30 degrees or less could be increased, and thus provide strong light emergent ~~lights could be obtained for~~in the front direction.

[0088]

[Examples 5 to 8]

Four ~~kinds of~~ molds (5) to (8) ~~on which~~with predetermined convexo-concave profiles were formed by a laser microprocessing technique~~ were prepared~~, an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds (5) to (7), and a silicone

resin having a refractive index of 1.40 was poured into the mold (8). Subsequently, the ~~poured~~ resins in the molds were cured, and then ~~taken out~~removed from the molds to obtain light control films (5) to (8) having a size of 23 cm x 31 cm (light control films of Examples 5 to 8).

[0089]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (5) to (8) were measured according to JIS B0601:2001, in the same manner as that used in Examples 1 to 4. The measurements ~~was~~ were performed at 5 arbitrary ~~5~~ positions on each light control film ~~for~~ in arbitrary directions, and averages of absolute values of slopes to the light entering surface of the obtained profile curves (θ_{ave}) were calculated. Further, for the same profile curves, values of the kurtosis (P_{ku}) defined in JIS B0601:2001 were obtained. The results obtained for the light control films (5) to (8) are shown in Table 3 (unit of the slope is ~~"degree"~~given as degrees). Further, by using a turbidimeter (NDH2000, Nippon Denshoku), hazes of the light control films (5) to (8) were measured according to JIS K7136:2000. The ~~measurement~~ results of the measurements are ~~also~~ shown in Table 3.

[0090]

[Table 3]

	θ_{ave} (degree)	P_{ku}	haze (%)
Example 5	42.3	2.590	82.7
	40.8	2.472	
	40.9	2.515	
	43.8	2.580	
	41.6	2.618	
Example 6	38.0	2.260	82.1
	36.9	2.268	
	36.8	2.347	
	38.5	2.320	
	37.1	2.267	
Example 7	24.5	1.925	77.5
	23.9	1.930	
	24.1	1.971	
	24.7	1.962	
	24.7	1.837	
Example 8	25.3	3.885	82.0
	25.9	4.058	
	24.6	3.835	
	25.5	3.697	
	24.6	3.932	

[0091]

As seen from the results shown in Table 3, the light

control films of the examples showed averages of absolute values of slopes not less than 20 degrees and not more than 75 degrees for all the profile curves. Further, the absolute values ~~of the~~for kurtosis were not less than 1.5 and not more than 5.0 for all the profile curves. Moreover, all the light control films of Examples 5 to 8 had a haze of 70% or higher, and thus ~~satisfied~~ had the optical characteristics required for obtaining favorable front luminance.

[0092]

Then, the light control films (5) to (8) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (5) to (8) were each disposed on a light guide plate so that the rough surface ~~should~~ served as the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (5) to (8) are shown in Table 4 (unit ~~is~~ s of "cd/m^2").

[0093]

[Table 4]

		luminance (cd/m^2)			
		Example5	Example6	Example7	Example8
parallel direction	left 45deg.	1020	1050	1100	1060
	left 30deg.	2110	2010	1840	1970
	0deg.	2390	2240	2000	2190
	right 30deg.	2070	1980	1820	1940
	right 45deg.	1010	1040	1090	1050
perpendicular direction	up 45deg.	764	875	1050	911
	up 30deg.	2240	2150	1990	2120
	0deg.	2390	2240	2000	2190
	down 30deg.	2230	2140	1980	2110
	down 45deg.	754	865	1040	901

[0094]

~~It was demonstrated by t~~The results shown in Table 4 demonstrate that, for the light control films of Examples 5 to 8, ~~only~~ by incorporating only one sheet of light control film into the backlight unit, the luminance for emergent ~~anglers~~ light at an angle of 30 degrees or less ~~could be~~is increased, and thus strong emergent light~~s~~ could be obtained ~~for~~ in the front direction.

[0095]

[Comparative Examples 1 to 3]

Three ~~kinds of~~ molds (9) to (11) on which predetermined convexo-concave profiles were formed by a laser microprocessing technique were prepared, and an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds. Subsequently, the poured

resin was cured, and then ~~taken out~~removed from the molds to obtain light control films (9) to (11) having a size of 23 cm x 31 cm (light control films of Comparative Examples 1 to 3).

[0096]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (9) to (11) were measured according to JIS B0601:2001, in the same manner as that used in Examples 1 to 4. For the obtained profile curves, averages of absolute values of slopes to the light entering surface (θ_{ave}) were calculated. Further, for the same profile curves, values of ~~the~~ skewness (P_{sk}), as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (9) to (11) are shown in Table 5 (unit of slope ~~is "degree"~~in degrees).

[0097]

[Table 5]

	θ_{avc} (degree)	$\|P_{sk}\|$	haze (%)
Comparative Example 1	31.9	1.261	80.6
	32.8	1.251	
	32.5	1.310	
	31.8	1.303	
	33.0	1.229	
Comparative Example 2	25.1	1.755	72.7
	25.6	1.673	
	24.6	1.719	
	25.5	1.759	
	25.4	1.786	
Comparative Example 3	20.3	2.159	68.0
	20.8	2.221	
	20.4	2.123	
	20.3	2.185	
	21.2	2.130	

[0098]

As seen from the results shown in Table 5, the light control films of Comparative Examples 1 to 3 showed averages of absolute values of slopes not less than 20 degrees and not more than 75 degrees for all the profile curves. However, the absolute values of ~~the~~ skewness ~~was~~

were more than 1.2 for all the profile curves.

[0099]

Then, the light control films (9) to (11) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (9) to (11) were each disposed on a light guide plate so that the rough surface of the light control film ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (9) to (11) are shown in Table 6.

[0100]

[Table 6]

		luminance (cd/m^2)		
		Comparative Example 1	Comparative Example 2	Comparative Example 3
parallel direction	left 45deg.	1220	1230	1240
	left 30deg.	1470	1430	1380
	0deg.	1440	1390	1320
	right 30deg.	1460	1430	1380
	right 45deg.	1210	1220	1230
perpendicular direction	up 45deg.	1460	1500	1550
	up 30deg.	1630	1600	1550
	0deg.	1440	1390	1320
	down 30deg.	1640	1610	1570
	down 45deg.	1450	1490	1540

[0101]

~~It was found from t~~The results shown in Table 6 demonstrate that when the light control films of Comparative Examples 1 to 3 were incorporated into the backlight unit, front luminance was not sufficient.

[0102]

[Comparative Examples 4 to 6]

Three ~~kinds of~~ molds (12) to (14) with ~~on which~~ predetermined convexo-concave profiles were formed by a laser microprocessing technique ~~were prepared~~, and an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds. Subsequently, the poured

resin was cured, and then ~~taken out~~removed from the molds to obtain light control films (12) to (14) having a size of 23 cm x 31 cm (light control films of Comparative Examples 4 to 6).

[0103]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (12) to (14) were measured according to JIS B0601:2001, in the same manner as that used in the examples. For the obtained profile curves, averages of absolute values of slopes to the light entering surface (θ_{ave}) were calculated. Further, for the same profile curves, values ~~of the~~ for kurtosis (P_{ku}), as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (12) to (14) are shown in Table 7 (units of slope ~~is "degree"~~ in degrees).

[0104]

[Table 7]

	θ_{ave} (degree)	P_{ku}	haze (%)
Comparative Example 4	21.2	7.720	73.2
	21.3	7.918	
	21.0	8.042	
	20.3	7.349	
	20.6	7.600	
Comparative Example 5	25.1	1.351	75.8
	25.7	1.347	
	24.4	1.306	
	25.7	1.416	
	24.8	1.299	
Comparative Example 6	31.2	5.885	77.1
	32.3	5.809	
	30.0	6.002	
	30.3	5.759	
	30.8	5.672	

[0105]

As seen from the results shown in Table 7, the light control films of Comparative Examples 4 to 6 showed averages of absolute values of slopes not less than 20 degrees and not more than 75 degrees for all the profile curves. However, the absolute values ~~of the~~for kurtosis were less than 1.5 or more than 5.0 for all the profile

curves.

[0106]

Then, the light control films (12) to (14) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (12) to (14) were each disposed on a light guide plate ~~so that~~with the rough surface of the light control film ~~should serve~~ as the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (12) to (14) are shown in Table 8 (as units ~~is~~ in "cd/m^2").

[0107]

[Table 8]

		luminance (cd/m^2)		
		Comparative Example 4	Comparative Example 5	Comparative Example 6
parallel direction	left 45deg.	1240	1190	1230
	left 30deg.	1390	1540	1430
	0deg.	1330	1550	1390
	right 30deg.	1390	1530	1430
	right 45deg.	1230	1190	1220
perpendicular direction	up 45deg.	1540	1380	1490
	up 30deg.	1560	1700	1610
	0deg.	1330	1550	1390
	down 30deg.	1580	1710	1620
	down 45deg.	1530	1370	1480

[0108]

It can be seen from the results shown in Table 8 that when the light control films of Comparative Examples 4 to 6 were incorporated into the backlight unit, front luminance was not sufficient.

[0109]

[Comparative Examples 7 and 8]

For commercially available light diffusive sheets (Comparative Examples 7 and 8), surface profiles of rough surfaces (light emergent surfaces) were measured at 5 arbitrary ~~5~~ positions on each sheet, in the same manner as that used in the examples, and averages of absolute values

of slopes of the profile curves (θ_{ave}) were obtained. Further, for the same profile curves, ~~the~~ skewness (P_{sk}) and ~~the~~ kurtosis (P_{ku}) were calculated. The results are shown in Table 9.

[0110]

[Table 9]

	θ_{ave} (degree)	$\lvert P_{sk} \rvert$	P_{ku}
Comparative Example 7	17.1	0.131	3.329
	17.2	0.130	3.277
	16.8	0.133	3.482
	16.9	0.126	3.261
	17.2	0.135	3.422
Comparative Example 8	10.9	0.752	3.673
	10.7	0.750	3.813
	10.5	0.736	3.618
	10.9	0.747	3.736
	11.1	0.736	3.691

[0111]

As seen from the results shown in Table 9, the light diffusive sheets of Comparative Examples 7 and 8 ~~were those that could not provide an average~~ had averages for of absolute values of slopes outside of the range of not less than 20 degrees and not more than 75 degrees at all the

measurement points.

[0112]

Then, the light diffusive sheets of Comparative Examples 7 and 8 were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light diffusive sheets of Comparative Examples 7 and 8 were each disposed on a light guide plate so that the rough surface of the light diffusive sheet ~~should serve~~was ~~as~~ the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results are shown in Table 10.

[0113]

[Table 10]

		luminance (cd/m^2)	
		Comparative Example 7	Comparative Example 8
parallel direction	left 45 deg	1190	1260
	left 30 deg.	1560	1330
	0 deg.	1580	1240
	right 30 deg.	1550	1330
	right 45 deg.	1180	1250
perpendicular direction	up 45 deg.	1360	1610
	up 30 deg.	1720	1500
	0 deg.	1580	1240
	down 30 deg.	1730	1520
	down 45 deg.	1350	1600

[0114]

As seen from the results shown in Table 10, when the conventional light diffusive sheets were incorporated into the backlight unit, favorable front luminance could not be obtained.

[0115]

[Examples 9 to 12]

Four ~~kinds of~~ molds (15) to (18) ~~on which~~having predetermined convexo-concave profiles were formed by ~~a~~ laser microprocessing ~~technique were prepared~~, an

ultraviolet curable resin having a refractive index of 1.50 was poured into the molds (15) to (17), and a silicone resin having a refractive index of 1.40 was poured into the mold (18). Subsequently, the poured resins were cured, and then ~~taken out~~removed from the molds to obtain light control films (15) to (18) having a size of 23 cm (for the direction perpendicular to the light source) x 31 cm (for the direction parallel to the light source) (light control films of Examples 9 to 12).

[0116]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (15) to (18) were measured according to JIS B0601:2001, ~~by~~ using a surface profiler (SAS-2010 SAU-II, MEISHIN KOKI). This surface profiler had a contact finger in the shape of a cone with a spherical tip ~~of which~~with a radius ~~was~~ of 2 μm and a conical angle of 60 degrees. The measurement interval was 1.0 μm.

[0117]

The measurement was performed at 5 arbitrary ~~5~~ positions on each light control film ~~for~~ in arbitrary directions, lengths of the obtained profile curves (L2) were measured, and ratios ~~(L_r) thereof to the lengths of bases of the sections (L1) (~~L_r = L2/L1~~)~~ were calculated. Further, for the same profile curves, values ~~of the~~for skewness ~~(~~P_{sk}~~)~~, as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (15) to (18) are shown in Table 11 (units of slope ~~is "degree"~~in degrees). Further, by using a turbidimeter (NDH2000, Nippon Denshoku), hazes of the light control films (15) to (18) were measured according to JIS K7136:2000. The measurement results are also shown in Table 11.

[0118]

[Table 11]

	L_r	$\|P_{sk}\|$	haze (%)
Example 9	1.677	0.097	82.7
	1.630	0.097	
	1.654	0.095	
	1.650	0.101	
	1.661	0.094	
Example 10	1.392	0.248	82.1
	1.330	0.237	
	1.360	0.253	
	1.341	0.251	
	1.346	0.237	
Example 11	1.265	0.461	96.5
	1.215	0.483	
	1.202	0.439	
	1.262	0.455	
	1.254	0.459	
Example 12	1.455	0.120	82.5
	1.489	0.126	
	1.450	0.117	
	1.513	0.126	
	1.457	0.121	

[0119]

As seen from the results shown in Table 11, the light control films of Examples 9 to 12 showed ratios ~~of the~~

~~lengths (L_r)~~ of not less than 1.1 and not more than 1.8 for all the profile curves. Further, the absolute values of ~~the~~ skewness were not more than 1.2 for all the profile curves. Moreover, all the light control films of Examples 9 to 12 had a haze of 70% or higher, and thus ~~satisfied~~ had the optical characteristics required for obtaining favorable front luminance.

[0120]

Then, the light control films (15) to (18) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (15) to (18) were each disposed on a light guide plate so that the rough surface ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (15) to (18) are shown in Table 12 (units ~~is~~ are "cd/m^2").

[0121]

[Table 12]

		luminance (cd/m^2)			
		Example 9	Example 10	Example 11	Example 12
parallel direction	L 45deg.	1090	1090	1110	1110
	L 30deg.	1820	1800	1750	1770
	0deg.	1920	1900	1830	1850
	R 30deg.	1800	1790	1740	1750
	R 45deg.	1100	1100	1120	1100
perpendicular direction	U 45deg.	1060	1070	1130	1110
	U 30deg.	1950	1930	1880	1900
	0deg.	1920	1900	1830	1850
	D 30deg.	1950	1930	1900	1900
	D 45deg.	1090	1110	1160	1140

[0122]

~~It was demonstrated by t~~The results shown in Table 12 demonstrate that, for the light control films of Examples 9 to 12, only by incorporating only one sheet of light control film into the backlight unit, the luminance for emergent anglers~~s~~ of 30 degrees or less could be increased, and thus strong emergent light~~s~~ ~~could be obtained for~~ was emitted in the front direction.

[0123]

[Examples 13 to 16]

Four ~~kinds of~~ molds (19) to (22) ~~on which~~ with predetermined convexo-concave profiles were formed by ~~a~~ laser microprocessing ~~technique were prepared~~, an ultraviolet curable resin having a refractive index of 1.50

was poured into the molds (19) to (21), and a silicone resin having a refractive index of 1.40 was poured into the mold (22). Subsequently, the poured resins were cured, and then ~~taken out~~removed from the molds to obtain light control films (19) to (22) having a size of 23 cm x 31 cm (light control films of Examples 13 to 16).

[0124]

Then, surface profiles of the rough surfaces (light emergent surface) of the light control films (19) to (22) were measured according to JIS B0601:2001, in the same manner as that used in Examples 1 to 4. The measurement was performed at 5 arbitrary ~~5~~ positions on each light control film ~~for~~ in arbitrary directions, lengths of the obtained profile curves (L2) were measured, and ratios ~~(L_r)~~ thereof to the lengths of bases of the sections ~~(L1)~~, i.e. ~~(L_r = L2/L1)~~ were calculated. Further, for the same profile curves, values of ~~the~~ kurtosis (P_{ku}), as defined in JIS B0601:2001 were obtained. The results obtained for the light control films (19) to (22) are shown in Table 13 (unit of slope is in "degrees"). Further, by using a turbidimeter (NDH2000, Nippon Denshoku), hazes of the light control films (19) to (22) were measured according to JIS K7136:2000. The results of these measurements ~~results~~ are ~~also~~ shown in Table 13.

[0125]

[Table 13]

	L_r	P_{ku}	haze (%)
Example 13	1.685	1.651	82.3
	1.679	1.651	
	1.761	1.700	
	1.657	1.624	
	1.682	1.676	
Example 14	1.376	4.023	76.2
	1.326	4.032	
	1.333	3.848	
	1.316	4.141	
	1.418	3.942	
Example 15	1.288	2.146	82.6
	1.250	2.206	
	1.261	2.148	
	1.275	2.248	
	1.276	2.099	
Example 16	1.326	2.260	94.3
	1.391	2.343	
	1.381	2.197	
	1.365	2.244	
	1.323	2.372	

[0126]

As seen from the results shown in Table 13, the light control films of the examples showed ratios of the lengths

~~(L_r)~~ not less than 1.1 and not more than 1.8 for all the profile curves. Further, the absolute values of ~~the~~ kurtosis were not less than 1.0 and not more than 4.5 for all the profile curves. Moreover, all the light control films of Examples 13 to 16 had a haze of 70% or higher, and thus ~~satisfied~~ had the optical characteristics required for obtaining favorable front luminance.

[0127]

Then, the light control films (19) to (22) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (19) to (22) were each disposed on a light guide plate so that the rough surface ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (19) to (22) are shown in Table 14 (units ~~is~~ in "cd/m^2").

[0128]

[Table 14]

		luminance (cd/m^2)			
		Example13	Example14	Example15	Example16
parallel direction	Left 45 deg.	1140	1130	1130	1070
	Left 30 deg.	1660	1690	1690	1880
	0 deg.	1700	1740	2010	1870
	Right 30 deg.	1630	1680	1670	1860
	Right 45 deg.	1150	1140	1140	1080
perpendicular direction	Up 45 deg.	1240	1200	1200	984
	Up 30 deg.	1800	1830	1830	2010
	0 deg.	1700	1740	2010	1870
	Down 30 deg.	1810	1840	1830	2000
	Down 45 deg.	1260	1230	1220	1020

[0129]

~~It was demonstrated by t~~The results ~~shown~~ in Table 14 show that, for the light control films of Examples 13 to 16, ~~only~~ by incorporating only one sheet of light control film into the backlight unit, the luminance for emergent angler~~s~~ of 30 degrees or less could be increased, and thus strong emergent light~~s could be obtained for~~ is emitted in the front direction.

[0130]

[Comparative Examples 9 to 11]

Three ~~kinds of~~ molds (23) to (25) ~~on which~~with predetermined convexo-concave profiles ~~were~~ formed by ~~a~~ laser microprocessing ~~technique~~ were prepared, and an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds. Subsequently, the poured resin was cured, and then ~~taken out~~removed from the molds to

obtain light control films (23) to (25) having a size of 23 cm x 31 cm (light control films of Comparative Examples 9 to 11).

[0131]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (23) to (25) were measured according to JIS B0601:2001, in the same manner as that used in Examples 1 to 4. The lengths of the obtained profile curves ~~(L2)~~ were measured, and ratios ~~(L_r)~~ thereof to the lengths of bases of the sections ~~(L1)~~, i.e. ~~(L_r = L2/L1)~~, were calculated. Further, for the same profile curves, values ~~of the~~for skewness (P_{sk}), as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (23) to (25) are shown in Table 15 (~~unit of~~ slope ~~is "degree"~~units in "degrees").

[0132]

[Table 15]

	L_r	$\|P_{sk}\|$	haze (%)
Comparative Example 9	1.202	1.261	81.5
	1.143	1.236	
	1.161	1.302	
	1.162	1.261	
	1.234	1.304	
Comparative Example 10	1.141	1.755	60.8
	1.186	1.741	
	1.113	1.785	
	1.166	1.708	
	1.130	1.719	
Comparative Example 11	1.121	2.159	64.4
	1.153	2.246	
	1.168	2.655	
	1.143	2.243	
	1.170	2.225	

[0133]

As seen from ~~the results shown in~~ Table 15, the light control films of Comparative Examples 9 to 11 ~~showed~~ had ratios ~~of the lengths (L_r)~~ not less than 1.1 and not more than 1.8 for all the profile curves. However, the absolute values of ~~the~~ skewness were more than 1.2 for all the profile curves.

[0134]

Then, the light control films (23) to (25) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (23) to (25) were each disposed on a light guide plate so that the rough surface of the light control film ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (23) to (25) are shown in Table 16.

[0135]

[Table 16]

		luminance (cd/m^2)		
		Comparative Example 9	Comparative Example 10	Comparative Example 11
parallel direction	left 45 deg.	1210	1250	1260
	left 30 deg.	1480	1380	1340
	0 deg.	1450	1300	1240
	right 30 deg.	1470	1370	1330
	right 45 deg.	1200	1240	1210
perpendicular direction	up 45 deg.	1440	1560	1600
	up 30 deg.	1640	1530	1510
	0 deg.	1450	1300	1240
	down 30 deg.	1650	1560	1500
	down 45 deg.	1440	1550	1590

[0136]

~~It was found from t~~The results ~~shown~~ in Table 16 show that when the light control films of Comparative Examples 9 to 11 were incorporated into the backlight unit, front luminance was not sufficient.

[0137]

[Comparative Examples 12 to 14]

Three ~~kinds of~~ molds (26) to (28) ~~on which~~with predetermined convexo-concave profiles were formed by ~~a~~ laser microprocessing~~ technique were prepared~~, and an ultraviolet curable resin having a refractive index of 1.50 was poured into the molds. Subsequently, the poured resin was cured, and then ~~taken out~~removed from the molds to obtain light control films (26) to (28) having a size of

23 cm x 31 cm (light control films of Comparative Examples 12 to 14).

[0138]

Then, surface profiles of the rough surfaces (light emergent surfaces) of the light control films (26) to (28) were measured according to JIS B0601:2001, in the same manner as that used in the examples. The lengths of the obtained profile curves ~~(~~L2~~)~~ were measured, and ratios ~~(~~L_r~~)~~ thereof to the lengths of bases of the sections ~~(~~L1~~)~~ (L_r = L2/L1) were calculated. Further, for the same profile curves, values of the kurtosis (P_{ku}), as defined in JIS B0601:2001, were obtained. The results obtained for the light control films (26) to (28) are shown in Table 17 (units of slope ~~is~~ in "degrees").

[0139]

[Table 17]

	L_r	P_{ku}	haze (%)
Comparative Example 12	1.162	4.573	74.4
	1.171	4.772	
	1.133	4.654	
	1.214	4.666	
	1.106	4.721	
Comparative Example 13	1.424	4.885	65.6
	1.407	4.925	
	1.389	4.782	
	1.376	4.807	
	1.394	5.059	
Comparative Example 14	1.221	7.720	64.3
	1.163	7.856	
	1.201	8.028	
	1.238	8.596	
	1.267	8.973	

[0140]

~~As seen from t~~The results ~~shown~~ in Table 17~~,~~ show that the light control films of Comparative Examples 12 to 14 ~~showed~~ had ratios ~~of the lengths (L_r)~~ not less than 1.1 and not more than 1.8 for all the profile curves. However, the absolute values of ~~the~~ kurtosis were less than 1.0 or more than 4.5 for all the profile curves.

[0141]

Then, the light control films (26) to (28) were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light control films (26) to (28) were each disposed on a light guide plate so that the rough surface of the light control film ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results obtained for the light control films (26) to (28) are shown in Table 18 (units ~~is~~ in "cd/m^2").

[0142]

[Table 18]

		luminance (cd/m²)		
		Comparative Example 12	Comparative Example 13	Comparative Example 14
parallel direction	left 45 deg.	1210	1220	1240
	left 30 deg.	1470	1440	1380
	0 deg.	1440	1390	1320
	right 30 deg.	1470	1430	1390
	right 45 deg.	1210	1220	1230
perpendicular direction	up 45 deg.	1450	1450	1550
	up 30 deg.	1630	1600	1550
	0 deg.	1440	1390	1320
	down 30 deg.	1640	1610	1570
	down 45 deg.	1450	1490	1540

[0143]

~~It was found from t~~The results ~~shown~~ in Table 18 show that when the light control films of Comparative Examples 12 to 14 were incorporated into the backlight unit, front luminance was not sufficient.

[0144]

[Comparative Examples 15 and 16]

~~For commercially available light diffusive sheets (Comparative Examples 15 and 16), surface~~ Surface profiles of rough surfaces (light emergent surfaces) of commercially available light diffusive sheets (Comparative Examples 15 and 16), were measured at 5 arbitrary ~~5~~ positions on each sheet in the same manner as that used in the examples,

lengths of the measured profile curves ~~(L2)~~ were measured, and ratios ~~(L_r)~~ thereof to the lengths of bases of the sections ~~(L1)~~, i.e. ~~(~~L_r = L2/L1~~)~~, were calculated. Further, for the same profile curves, the skewness (P_{sk}) and the kurtosis (P_{ku}) were calculated. The results obtained for the light diffusive sheets of Comparative Examples 15 and 16 are shown in Table 19.

[0145]

[Table 19]

	L_r	$\lvert P_{sk} \rvert$	P_{ku}
Comparative Example 15	1.078	0.177	3.436
	1.071	0.169	3.303
	1.069	0.176	3.389
	1.064	0.168	3.274
	1.066	0.174	3.498
Comparative Example 16	1.035	0.725	3.673
	1.064	0.722	3.702
	1.065	0.747	3.557
	1.029	0.701	3.622
	1.028	0.689	3.574

[0146]

As seen ~~from the results shown~~ in Table 19, the light diffusive sheets of Comparative Examples 15 and 16 ~~were those that could not provide~~did not have a ratio ~~of the lengths (L_r)~~ not less than 1.1 and not more than 1.8 at all the measurement points.

[0147]

~~Then~~Next, the light diffusive sheets of Comparative

Examples 15 and 16 were each incorporated into a 15-inch edge light type backlight unit (one cold-cathode tube was provided ~~for~~ at each of upside and downside edges), and front luminance was measured. That is, the light diffusive sheets of Comparative Examples 15 and 16 were each disposed on a light guide plate so that the rough surface of the light diffusive sheet ~~should serve as~~was the light emergent surface, and the luminance was measured at each emergent angle~~r~~ for lines in the parallel and perpendicular directions with respect to the light source (cold-cathode tubes), which lines were positioned at the center of the backlight unit (1 inch = 2.54 cm). The results are shown in Table 20.

[0148]

[Table 20]

		luminance (cd/m²)	
		Comparative Example15	Comparative Example 16
parallel direction	left 45 deg.	1180	1260
	left 30 deg.	1560	1330
	0 deg.	1560	1240
	right 30 deg.	1550	1330
	right 45 deg.	1180	1250
perpendicular direction	up 45 deg.	1350	1610
	up 30 deg.	1710	1500
	0 deg.	1560	1240
	down 30 deg.	1720	1520
	down 45 deg.	1360	1600

[0149]

As seen from the results shown in Table 20, when the conventional light diffusive sheets were incorporated into ~~the~~ a backlight unit, favorable front luminance could not be obtained.

[0150]

As clearly seen from the results of the ~~aforementioned~~ foregoing examples, the light control films of the ~~examples~~ present invention exhibited superior front luminance and appropriate light ~~diffusing property~~diffusion, because the rough surfaces thereof ~~were designed so that~~

~~they should satisfy the~~have a specific configuration. Further, by incorporating such light control films into a backlight unit, backlight units exhibiting high front luminance ~~and not suffering from~~without glare ~~and~~ or generation of an interference pattern were ~~could be~~ obtained.

~~Brief Description of the Drawings~~

~~[0151]~~

~~[Fig. 1] Drawing for explanation of the rough surface of the light control film of the present invention~~

~~[Fig. 2] Drawing for explanation of the profile curve of the light control film of the present invention~~

~~[Fig. 3] Sectional views showing embodiments of the light control film of the present invention~~

~~[Fig. 4-1] Sectional view of a three-dimensional shape of a convex portion used for simulating difference in emergent angler characteristics caused by the shape~~

~~[Fig. 4-2] Drawing showing an example of three-dimensional shape of convex portion used for simulating difference in emergent angler characteristics caused by the shape~~

~~[Fig. 5] Drawing showing results of three-dimensional simulation~~

~~[Fig. 6] Drawing showing results of three-dimensional simulation~~

~~[Fig. 7] Drawing showing results of three-dimensional simulation~~

~~[Fig. 8] Drawing showing results of three-dimensional simulation~~

~~[Fig. 9] Drawing showing results of three-dimensional simulation~~

~~[Fig. 10] Drawing showing results of three-dimensional simulation~~

~~[Fig. 11] Drawing showing results of three-dimensional~~

~~simulation~~

~~[Fig. 12] Perspective view of an example of the rough surface of the light control film of present invention~~

~~[Fig. 13] Drawing showing an embodiment of the backlight unit of the present invention~~

~~[Fig. 14] Drawing showing an embodiment of the backlight unit of the present invention~~

Abstract

~~A~~ The light control film ~~enabling improvement in~~provides improved front luminance~~, having~~ and appropriate ~~light diffusing property and free from~~diffusion without the problems of interference pattern, glare~~ etc. is provided~~.

~~A~~ The light control film ~~10 having~~has a rough surface ~~is constituted so~~ that, for substantially any ~~an~~ arbitrary cross section perpendicular to a base plane of the film, has an ~~a condition that~~ average ~~(θ_{ave}, degree)~~ of absolute values of slope, with respect to the base plane of a curve along the edge of the cross section, which is not less than 20 degrees and not more than 75 degrees, and has an absolute value of skewness (JIS B0601:2001) of the profile curve ~~is~~ of not more than 1.2 ~~should be satisfied for substantially any profile curve~~.